Amendments to the Specification:

Please replace paragraph [0045] with the following paragraph:

[0045] While the different eigenstates of an observable are orthogonal in the relevant Hilbert space, entities in differing eigenstates may or may not be capable of interference effects. ~~Coherent photons are an example of a first situation in which they do not interfere, because vertical polarization states do not interfere with horizontal polarization states. Electrons are an example of a second situation in which they do interfere, because an electron in the spin-up eigenstate can interfere with an electron in the spin-down eigenstate. In both situations however,~~ For constructive or destructive interference to occur, the phases of the two entities need to be appropriately aligned. For constructive interference their phases coincide (i.e. are in phase), and for destructive interference their phases are opposed (i.e. are π out of phase).

Please replace paragraph [0047] with the following paragraph:

[0047] It is also well known that in the following prototypical SOSCP description it can be assumed, without a loss of generality, that the initial state of the entity under consideration is $\Psi = 1/\sqrt{2}\left(|0\rangle + |1\rangle\right)$, where the coefficients are taken to be equal and normalized, and the orthogonal eigenstates are described in a generalized computation basis (where the states $|\mathbf{0}\rangle$ and $|\mathbf{1}\rangle$ correspond to the two alternative values for a single bit). Equivalent SOSCPs for entities with less constrained initial states, described in less restricted basis states, are readily derivable through well known generalizations of the following SOSCP. It is also assumed that the entity under discussion is an example of the ~~first~~ situation in which the two orthogonal basis states do not interfere, akin to the horizontal and vertical polarization states of a photon. ~~The second situation, where the two orthogonal basis states do interfere, can be treated as a special case of the discussion of the first situation.~~

Please replace paragraph [0055] with the following paragraph:

[0055] An element of the present invention that is capable of effecting the above described eigenstate distinguishing operation is correspondingly termed a state distinguisher. An element of the present invention that is capable of effecting the above described eigenstate altering operation is correspondingly termed a state conditioner. An element of the present invention that is capable of effecting the above described phase aligning operation is correspondingly termed a state conditioner. The state conditioner (also referred to as a preparatory conditioner, when the eigenstate altering and/or phase aligning operations condition the entity's state in preparation for a subsequent operation) will regularly be comprised of at least the eigenstate altering operation, and will often include the phase aligning operation, when the appropriate phase alignment is at least potentially not present. An element of the present invention that is capable of effecting the destructively interfering operation, and related later described operations that are capable of revealing manifestations of interference, are accordingly termed interference actuators.~~The operation of the prototypical SOSCP for entities in the second situation differs from its operation for those in the first situation in that the eigenstate altering second core operation can be, but is not limited to, a trivial (i.e. null) operation. Because the entities in the second situation are already capable of revealing interference effects, it may not be necessary to alter their eigenstates for the other prototypical SOSCP core operations to function.~~

Please replace paragraph [0057] with the following paragraph:

[0057] A focused intersection optical apparatus embodiment ~~110~~**100** of the present invention schematically depicted in Fig. **1** provides a first means of physical realizing the operations of the prototypical SOSCP. The entities utilized by the focused intersection optical apparatus embodiment **100** are photons that are schematically depicted as traveling in the direction **102** when incoming along the

optical fiber **104**. For the suitable embodiments of the present invention, entity paths that are shown as being constrained by elements such as optical fiber **104** can often also be configured with a free (i.e. unconstrained) path, so long as they are appropriately directed and factors such as loss and dispersion are controllable, hence it should be understood that the scope of the present invention also encompasses these alternative embodiments. ~~The eigenstate distinguishing operation is not shown in this depiction, since a wide variety of means, such as birefringent crystals, by which it can be realized are well known. One such means of conducting the~~The eigenstate distinguishing operation of the focused intersection optical apparatus embodiment **100** ~~is producing~~involves the well known means of producing ~~a~~ photons in ~~a~~ superpositions of horizontal and vertical polarization states through type II spontaneous parametric down conversion~~, and using a suitably aligned birefringent crystal to direct each polarization state of the photon along a separate path~~. These photons in superpositions of horizontally and vertically polarized states travel in direction **102** along optical fiber **104** to a state distinguisher. In the focused intersection optical apparatus embodiment **100** the state distinguisher is a suitably aligned bi-refringent crystal **106** that directs each polarization component of the photon in differing directions. A horizontally polarized component of the photon is directed along path **112**, and a vertically polarized component is directed along path **114**, wherein both of paths **112** and **114** generally progress from left to right in direction 102 as depicted in Fig. **1**. The horizontally polarized component path **112** proceeds along optical fiber H **116** and the vertically polarized component path **114** proceeds along optical fiber V **118**. In this embodiment, the eigenstate altering operation is achieved by passing the optical fiber H **116** through a half wave plate **120** thereby rotating the polarization of the horizontally polarized photon component by $\pi/2$. By effecting the $\pi/2$ rotation of the horizontally polarized photon component, the half wave plate **120** functions as the state conditioner in the focused intersection optical apparatus embodiment **100**, and prepares the condition of the horizontally polarized photon component for following operations. After passing through the half wave plate **120**, the photon component proceeding along optical fiber H **116** is polarized in the vertical direction. To ensure clarity in the subsequent descriptions, the photon component

which was originally polarized in the horizontal direction will continue to be referred to as the horizontally polarized component, even when its polarization direction has been rotated to the vertical direction. The choice of which path to pass through the half wave plate is not critical, as long as just one path passes through it. The optical fibers H **116** and V **118** then pass through selectable photon counters **122** and **124**, respectively. Inclusion of the selectable photon counters is an optional feature that is relevant for later described embodiments which involve the option of selectively preserving or demolishing photons' superpositions of states. The selectable photon counters **122** and **124** are capable of counting the passage of a photon only if selected to do so. The selectable photon counters **122** and **124** are configured so that they cannot, even in principle, register the passage of a photon when unselected, and hence will not demolish the photon's superposition of linearly polarized states unless they are expressly selected.

Please replace paragraph [0058] with the following paragraph:

[0058] After passing through the selectable photon counters **122** and **124**, The optical fibers H **116** and V **118** direct the paths **112** and **114**, respectively, to intersect at a crossing angle θ **126**. A general region of intersection **128** encompasses the area where the paths **112** and **114** cross. Within the region of intersection **128** is an interference zone **130** where the photon components directed on paths **112** and **114** are potentially capable of revealing interference effects. The focused intersection optical apparatus embodiment ~~110~~ <u>100</u> can accomplish the phase aligning operation by controlling the lengths along the two paths **112** and **114** so that the two photon components arrive at the interference zone **130** π out of phase. Alternatively, one or more well known types of phase shifters (not shown) can be arranged along either or both of the paths **112** and **114** for accomplishing the π phase shift of the phase aligning operation. <u>By effecting the phase aligning operation (when required), the phase shifter and/or path length control function as facets of the state conditioner in the focused intersection optical apparatus</u>

embodiment 100, and prepare the condition of the photon components for following operations. The destructively interfering operation is accomplished by the crossing of the paths **112** and **114** at the interference zone **130**, and hence the crossing paths defined by the right terminal ends of the paths 112 and 114 are the interference actuator of the focused intersection optical apparatus embodiment 100. Within the general region of intersection **128**, the conditionally responding operation can be accomplished in differing ways. Three examples of the variety of means available for realizing the conditionally responding operation are described in Figs. **2**, **3**, and **4**.

Please replace paragraph [0060] with the following paragraph:

[0060] Although the description of the focused intersection optical apparatus embodiment **100** ~~**110**~~ is directed towards conducting the prototypical SOSCP, it should be understood that the focused intersection optical apparatus embodiment ~~**110**~~ **100** is also adaptable for conducting prototypical SOSDPs as described in more detail immediately following. Although the optical embodiments are described as utilizing photons in superposition of linear polarization states, it should be understood that the scope of the present invention also includes alternative optical embodiments that can, with the appropriate well known modifications, utilize circular, elliptical, and other polarization states as well.

Please replace paragraph [0061] with the following paragraph:

[0061] The focused intersection optical apparatus embodiment ~~**110**~~ **100** is adaptable for both statistical measures of ensembles of entities as well as approaches that are focused on producing functional performance with individual entities. The various means for conducting the conditionally responding operation are generally disposed within the region of intersection **128** of Fig. **1**. The three approaches depicted in Figs. **2**, **3**, and **4** are a fraction of all possible means of conducting the conditionally

responding operation, and do not preclude the employment of alternative approaches that can achieve the desired objectives. Any approach to conducting the conditionally responding operation that is capable of enabling performance of the functions of any embodiment of the present invention, when utilized in concert with the other aspects of those embodiments, is within the scope of the present invention.

Please replace paragraph [0067] with the following paragraph:

[0067] A pattern-based optical apparatus embodiment **510** is schematically depicted in Fig. **5**. From its initiation through to when the photon components pass the selectable photon counters **122** and **124**, the pattern-based optical apparatus embodiment **510** is equivalent to the focused intersection optical apparatus embodiment ~~**110**~~**100**. After passing the selectable photon counters **122** and **124**, the optical fibers H **116** and V **118** terminate at emitting locations **512** and **514**, respectively. The emitting locations **512** and **514** are depicted as arranged on an emission plane **516** for simplicity, although other arrangements can be utilized as long as the relative positions of the locations **512** and **514** are known. The locations **512** and **514** are separated by a distance A **518** along the emission plane **516**. The ends of the optical fibers H **116** and V **118** are depicted as arranged in parallel orientations at right angles to the emission plane **516** for simplicity, although other arrangements can also be utilized. The end of the optical fiber H **116** is aligned in a direction H **520** and the end of the optical fiber V **118** is aligned in a direction V **522**. The directions H **520** and V **522** are parallel and separated by the distance A **518**. A detection plane **524** is parallel to, and is a separation L **526** from the emission plane **516**. The direction H **520** intersects the detection plane **524** at a position D_H **528** and the direction V **522** intersects the detection plane **524** at a position D_V **530** so that the positions D_H **528** and D_V **530** are then also separated by the distance A **518**. Photon detectors **532** and **534** have their apertures located at the positions D_H **528** and D_V **530**, respectively. The apertures of the photon detectors **532** and **534** have openings of widths W **536**.

Please replace paragraph [0068] with the following paragraph:

[0068] When a photon that enters the pattern-based optical apparatus embodiment **510** is in the superposition of linearly polarized states, the photon components that are emitted ~~form~~ from the optical fibers H **116** and V **118** can have a controllable phase relationship between them. Since the wavelength of the photon components is known, the distance A **518** and the separation L **526** can be chosen to produce a selected interference pattern (not shown) at the detection plane **524**. By providing the conditions in which the photon components can potentially interfere, the region of the first EM embodiment **610** between the emission plane **516** and the detection plane **524**, inclusive, functions as this embodiment's interference actuator because it is not possible to conclusively distinguish which of the locations **512** and **514** emitted a given photon when it arrives at detection plane **524**. The selected interference pattern can have its central maxima centered between the positions D_H **528** and D_V **530**, and its first minima on either side of its central maxima centered at the positions D_H **528** and D_V **530**. When a photon that enters the pattern-based optical apparatus embodiment **510** is not in the superposition of linearly polarized states, the photon is either emitted at the location **512** from the optical fiber H **116** or at the location **514** from the optical fiber V **118**, and is initially directed in the direction H **520** or the direction V **522**, respectively. Consequently, the probability distribution of the position at which the photon will reach the detection screen **524** is a Gaussian distribution centered on either the position D_H **528** for a photon emitted by optical fiber H **116**, or centered on the position D_V **530** for a photon emitted by optical fiber H **118**. Thus, when photons are not in the superposition of linearly polarized states, there is a maximum probability that the individual photons are detected at the positions D_H **528** or D_V **530**; and when the photons are in the superposition of linearly polarized states, there is a maximum possible reduction in probability of detecting the photons at the positions D_H **528** and D_V **530**, in comparison to when the photons are not in the superposition of linearly polarized states. The contrast in probability of detection by the photon detectors **532** and **534** can be adjusted by varying the photon detector aperture

widths W **536**. A greater width W **536** is desired to enable higher photon counts when the photons are not in the superposition of linearly polarized states, while a lesser width W **536** is desired to enable lower photon counts when the photons are in a superposition of linearly polarized states. Since the goal is to maximize the contrast between the two situations, an optimal width W **536** will be determined according to the individual circumstances of the photon wavelengths, the sensitivities of the photon detectors **532** and **534**, the specific geometries employed and other particular details of a given realization of the pattern-based optical apparatus embodiment **510**.

Please replace paragraph [0071] with the following paragraph:

[0071] Electrons enter the first EM embodiment **610** moving in the initial direction **614**. The electrons undergo the eigenstate distinguishing operation when they pass through a first sector **615** that confines a magnetic field B_0 **616** that is directed in the positive y direction. The eigenstate distinguishing operation is achieved when the paths of the two components of the electrons diverge due to this field. The magnetic field B_0 impels the path of a parallel spin (i.e. spin-up) component **618** in the positive y direction, while it impels the path of an antiparallel spin (i.e. spin-down) component **620** in the negative y direction. <u>The magnetic field B_0 in the first sector **615** operates as the state distinguisher in the first EM embodiment **610** by effecting the spatial divergence of the spin-up **618** and spin-down **620** components, and prepares the conditions of the electron components for following operations.</u> The ten successive sectors, from left to right, of the first EM embodiment **610** are electromagnetically shielded (not shown), by any of a number of well known ways, from the fields in the other sectors so that the fields in one sector do not materially affect electrons in the other sectors. A spatial separation develops between the path of the spin-up component **618** and the path of the spin-down component **620** as they progress through an EM field-free second sector **622**. In a third sector **624** a magnetic field $-B_0$ **625** directed in the negative y direction counters the diverging movement of the spin-up and spin-down components so that they progress into a

fourth sector **626** in substantially parallel paths **628** and **630**, respectively. The eigenstate altering operation and the phase aligning operation facets of the preparatory state conditioner are disposed in the fourth sector **626** ~~provides an opportunity to conduct the phase aligning operation~~. The eigenstate altering operation involves flipping the spin of one of the spin components traversing either path **628** or **630**, by at least one of an assortment of well known means. After ensuring that the flipping effect is isolated to affecting just one of the spin component paths **628** and **630** by an appropriate shielding, the spin flip can be accomplished by brute force EM fields, or by the application of a more judicious procedure such as a Datta-Das spin FET. The phase aligning operation functions by selectively modifying (via any of a number of well known means) the phase of at least one of the spin components of the electron traversing paths **628** and **630** so that they are subsequently π out of phase. ~~As noted earlier, the eigenstate altering operation can be a trivial (i.e. null) operation in this case since the eigenstates are already capable of revealing evidence of destructive interference without being altered.~~

Please replace paragraph [0072] with the following paragraph:

[0072] The fourth sector **626** also provides an opportunity to respond to the spin states of the electron progressing through the first EM embodiment **610**. The electron's spin can be responded to by any means capable of distinguishing between the paths **628** and **630**. However, the electron's superposition of spin states will be demolished when the means to distinguish between the paths **628** and **630** is capable of being conducted, even if only in principle, in the fourth sector **626**. To be capable of selectively conducting the prototypical SOSCP as either a preserving or demolishing protocol with the same realization of the first EM embodiment **610**, the means for responding to the electron's spin, such as distinguishing between the paths **628** and **630**, cannot be possible, even in principle, except when conducting the prototypical SOSCP as a demolishing protocol. The magnetic field $-B_0$ **625** is also applied in a fifth sector **631** to redirect the spin-up component path **628** and the spin-down component path **630**

into converging paths **632** and **633**, respectively. A sixth sector **634** confines a magnetic field B_1 **636** in the positive y direction that is of a lesser magnitude than the magnetic field $-B_0$ **625**, but is applied across the entire breadth of the sixth sector **634**. The sixth sector **634** is of greater extent in the x direction than the fifth sector **631**, the third sector **624**, or the first sector **614**. In the sixth sector **634** the rate of convergence of the paths **632** and **633** is progressively moderated so that the paths coincide in a single path **638** through a seventh sector **640**, and thereby achieve the destructively interfering operation<u>, and hence function as an interference actuator,</u> by recombining the two phase aligned spin components of the electron throughout the seventh sector **640**. The seventh sector **640** confines an electric field E_z **642** directed in the positive z direction that will impel an electron present in the seventh sector **640** out of the plane of Fig. **6** to enable the conditionally responding operation. Because an electron that was originally in the superposition of spin states is destructive interfering with itself while traversing the path **638** through the seventh sector **640**, it will not experience the electric field E_z **642** and continues along the path **638** to an eighth sector **644** without leaving the plane of Fig. **6**. An electron that was not originally in the superposition of spin states will not be destructively interfering in the seventh sector **640**,and hence will experience the electric field E_z and be impelled out of the plane of Fig. **6**. An electron detector (not shown) can be situated so that it will register an electron that is impelled out of the plane of Fig. **6** and thereby provide the capability of implementing the conditionally responding operation.

Please replace paragraph [0079] with the following paragraph:

[0079] Tactics for accomplishing the resurrecting operation will vary, depending at least in part on the individual circumstances of specific realizations of the prototypical SOSC-PP. For the focused intersection optical apparatus embodiment ~~110~~<u>100</u>, the different approaches for conducting the conditionally responding operation are examples of the individual circumstances that affect how the resurrecting operation is conducted. A similar first optical resurrecting tactic is suitable for both the

photo detector approach **210** and the scattering approach **310**, while a second, related optical resurrecting tactic is suitable for the imperfect mirror approach **410**. Although the resurrecting operation is not exclusively applicable to entities that were initially in a superposition of states and that whose superposition of states were not demolished during the prototypical SOSCP, it can be of prominent significance in relation to these entities that maintain at least a partial degree of superposition of states during the prototypical SOSCP. Accordingly, the optical resurrecting tactics specifically described herein are primarily designed to accommodate accomplishing the resurrecting operation with such entities.

[0080] The first optical resurrecting tactic addresses the situation wherein the horizontally and vertically polarized photon components continue along the paths **112** and **114**, respectively, after passing through the interference zone **130**. In this situation, the photon components have not undergone demolishing interactions with either the photon detector **212** in the photo detector approach **210**, or the scattering element **312** in the scattering approach **310**. The photon components continuing along the paths **112** and **114** are directed into uptake optical fibers H **216** and V **214**, respectively. Photon components in the optical uptake fiber H **216** are directed through another half wave plate (not shown) that reverses the $\pi/2$ rotation of the polarization direction due to the half wave plate **120**. This rotation of the polarization direction of the photon components in the uptake optical fiber H **216** from the vertical direction to the horizontal direction accomplishes the undoing of the eigenstate altering operation. The two photon components are subsequently directed along controlled paths which are eventually recombined into a single exit optical fiber (not shown). These controlled paths utilize the aforementioned phase shifters and/or path length modifications to undo the π phase shift between the components instituted during the prototypical SOSC-PP. The recombining of the components in the single exit optical fiber is effected so as to undo the separating effect of the eigenstate altering operation. The undoing of the separating effect can be by means of a birefringent crystal, a coinciding of the paths **112** and **114** guided by internal reflections of the uptake optical fibers H **216** and V **214**, respectively, or other well known means. The

result is a photon that substantially replicates the significant aspects of the initial superposition of linearly polarized states of the photon upon which the prototypical SOSC-PP was conducted.

Please replace paragraph [0118] with the following paragraph:

[0118] A first means of achieving the selective mode feature with the focused intersection optical apparatus embodiment ~~110~~ 100 is further illustrative of the selective mode class of embodiments. As described previously, the photo detector approach **210**, the scattering approach **310**, and the imperfect mirror approach **410** for conducting the conditionally responding operation are all capable of being conducted in either a preserving or a demolishing mode. Implementing the selective mode feature as a pre-responding/discerning option is readily achievable with the selectable photon counters **122** and **124**. Implementing the selective mode feature as a post-responding/discerning option can be achieved by disposing another pair of selectable photon counters **122** and **124** (not shown) along the paths **214** and **216**, respectively, after cessation of the destructively interfering operation and before the resurrecting operation. Implementing both pre- and post-responding/discerning can hence be achieved by disposing selectable photon counters in both of these manners. It is important to note that the previously described caveat regarding the selectable photon counters being unable to register a photon, even in principle, unless they are selected to do so remains necessary for the same realization to be capable of performing in both a preserving and a demolishing mode.

Please replace paragraph [0119] with the following paragraph:

[0119] It may be desired that protocols according to the present invention operate in a preserving mode, but that the continued existence of the entity is unneeded or even unwanted following its interaction with the protocol. It is possible that an unintended post-protocol interaction could demolish an entity's

superposition of states and thereby change the responding/discerning outcome of the protocol in a form of a delayed-choice effect. In the example of the focused intersection optical apparatus embodiment ~~110~~100, as long as the photon's superposition of linearly polarized states is intact a demolishing interaction can occur which may alter the outcome of a confirming/discerning and preserving protocol. Since unintended environmental decoherence can be a pervasive issue when conducting quantum operations, it is desirable to be capable of avoiding this possibility. One means of avoiding the post-responding/discerning outcome alteration is to conduct momentum measurements on the photon components following cessation of the conditionally responding/discerning operation. It is a well known consequence of the Heisenberg principle that an exacting measurement of a photon's momentum precludes the determination of any position information about that photon. If the photon components' momentums are determined as a sum after the conditionally responding/discerning operations, and it is not possible to determine which component contributed what amount to that momentum measurement, then the position information, i.e. the which-path information, is destroyed. The photon's superposition of linearly polarized states status will be thereby preserved even though the photon itself was not. This process can be readily employed as a selectable alternative, in the imperfect mirror approach **410** for example, by selectively controlling the angle of inclination of the plane of the imperfect mirror **410** to the plane of Fig. **4**, whereby at one angle of inclination the photon components are reflected towards the above described momentum measurements, and at another angle they are not. The selective control of the angle of inclination can be a predetermined choice or alterable in response to other events and inputs such as the outcomes of other protocols.

Please replace paragraph [0132] with the following paragraph:

[0132] The interrelated protocols embodiment **710** schematically depicted in a perspective view in Fig. **7** demonstrates a sample collection of the means in which various combinations of protocols are able to

provide the protocol networks' capabilities. The particular means that comprise the interrelated protocols embodiment **710** are merely a representative selection of means with which the present invention can provide the protocol networks' capabilities, and are not limiting of the overall variety of available means. A pair of modified versions of the focused intersection optical apparatus embodiment ~~**110**~~ **100** are among the components that comprise the interrelated protocols embodiment **710**. These modifications to the focused intersection optical apparatus embodiment ~~**110**~~ **100** may involve substituting for and/or excluding at least one of the selectable photon counters **122** and **124**, utilizing at least one alternative means for achieving the conditionally responding or discerning operations, and/or interrelating at least one of any remaining photon counters or their substitutes with each other and/or with at least one of any conditionally responding or discerning means employed.

Please replace paragraph [0133] with the following paragraph:

[0133] In Fig. **7**, components of the modified focused intersection optical apparatuses are referenced by the same part number as indicates the same component of the focused intersection optical apparatus embodiment ~~**110**~~ **100** in Fig. **1** (except for an ending letter in Fig. **7** which distinguishes the components of one of the pair of modified focused intersection optical apparatuses from the components of the other). A first modified focused intersection optical apparatus **712** is disposed in Fig. **7** above a second modified focused intersection optical apparatus **714**. Like numbered components of the pair of modified focused intersection optical apparatus embodiments ~~**110**~~ **100** are distinguished from each other by ending in a "F" if indicating a component of the first modified focused intersection optical apparatus **712**, and ending in a "S" if indicating a component of the second modified focused intersection optical apparatus **714**. Signal photons traverse through both the first modified focused intersection optical apparatus **712** and the second modified focused intersection optical apparatus **714** from left to right, as shown in Fig. **7**.